

ATTACHMENT 3
MOBILE CLOSED CIRCUIT
TELEVISION SYSTEM

FOR

PROCUREMENT OF 40 FT LOW-FLOOR
BATTERY ELECTRIC BUSES

SPECIFICATION NO. VE21-054



Massachusetts Bay Transportation Authority
Vehicle Engineering
Boston, Massachusetts

PART 1 - GENERAL

1.1 GENERAL DESCRIPTION

- A. This Section specifies the installation of a mobile IP based video surveillance system on MBTA buses. The mobile IP video surveillance system shall integrate to the existing MBTA CCTV system that is a real time IP video system utilizing IP based cameras. The video is viewed throughout the MBTA system using the Genetec Security Center client.
- B. The CCTV software installed on fleet hardware must support a non-proprietary, open architecture platform which is fully ONVIF profile S and G compliant and must have been granted the SAFETY Act Designation and Certification by the U.S Department of Homeland Security (DHS). Video management software must also be currently listed on DHS website at the time of bid.
- C. The CCTV system utilizes the MBTA's Security Wide Area Network (SWAN) and MBTA's Wide Area Network (WAN) as a means of transmitting IP video to various locations throughout the MBTA system for viewing and recording. The system expansion shall incorporate IP fixed cameras, Multi-Stream Megapixel CCTV Cameras, video monitors, Network Video Recorders (NVRs)/Video Management Systems (VMSs), the Genetec software, network switches, codecs, and any other hardware or software required to transmit/receive video over an IP network for a complete and functional system.
- D. The Genetec client allows MBTA personnel to access live and recorded video streams from any camera, encoder, DVR, or NVR on the system and to create and store video clips and snapshots locally. The Genetec clients are currently installed on multiple computer workstations within the six (6) Hub Centers, Operations Control Center, and on individual computer workstations throughout the MBTA network
- E. The Contractor shall fully integrate all the new cameras and video streams into the Genetec system and shall geospatially place new icons onto new and existing system maps. The icons shall allow access to the camera's controls and video streams. The functionality shall match that of the existing integrated cameras. All camera device monitoring and systems shall be activated and tested at the Contractor's bus manufacturing facility. Testing shall include, but not be limited to: status, loss of video, faults, failures, alarms, and all tampering related events/alarms.
- F. All CCTV cameras/endpoints shall be entered into the Genetec system with nomenclature submitted to, and approved by, the MBTA Security and Emergency Management Department. All maps required to properly represent the endpoint locations shall be in scaled format and may utilize the bus manufacturer's CAD contract drawings. It is the Contractor's responsibility to convert/import/translate the CAD drawings into a format that is applicable for the project; all extraneous information shall be removed from the CAD drawing for a clear representation of the equipment installation. All device icons shall be based on the MBTA standards; if a standard has not yet been established for a device, then the Contractor shall work with the MBTA to develop an icon standard for that device.
- G. The Contractor shall configure all Fixed IP CCTV cameras to be set up to dual stream H.265 images. Fixed IP Cameras shall have one stream with a resolution of 1920x1080 and a frame rate of 8 fps or greater for NVR recording; and the other stream shall have a resolution of 1920x1080, and a frame rate of 15 fps or greater for live viewing. The 360 Degree IP Cameras shall each have four stitched H.264 800x600 streams representing different viewed angle ranges of the camera for a composite

stream of 1600x1200 and a rate of 8 fps for NVR recording, and shall also output four streams of the same viewed angles at a resolution of 800x600 stitched for a composite stream of 1600x1200 and a rate of 15 fps, or greater, for live viewing. Before CCTV camera set-up, the Contractor shall verify all camera settings with the Engineer, or an MBTA representative. All live streams shall be either multicast streams sent directly from the camera to the clients, the VMS/NVR shall facilitate the connection, or the stream shall be replicated by a server on the MBTA network to avoid increased utilization of the 4G and 5G LTE. All recorded streams shall be via multicast or unicast stream from the camera to the On-Bus Network Video Recorder. The compression on a camera shall not exceed 30%.

- H. The CCTV system is currently in use by MBTA personnel and is considered a critical system for MBTA Operations and security. All system improvements and changes must be coordinated in advance so as to not impact operations. This may require the Contractor to perform installation, testing, upgrades or system outages at off-peak or non-revenue times.
- I. For the purpose of Configuration Management, the Contractor must inform the MBTA of the length of time the Contractor will be making any system modifications. The dates and length of downtime of the system must be submitted in writing on the Contractor's letterhead to the Security and Emergency Management Department and the MBTA's MCMC via the MBTA project manager and must be approved by those groups. The Contractor shall complete all background maps, plan all alarms, and submit all licenses prior to doing any work on the MBTA's Genetec system. The Contractor must submit, at least 30 days in advance, for a two-week window in which to complete all work on the MBTA's Genetec system; the Contractor may submit for additional time, but time may be limited due to other active contracts needing access to the system. The Contractor must complete a backup of the system prior to working on the system. The Contractor shall label the backup media with the contents, date, and time of the backup. The Contractor must maintain this backup for at least 120 days after the updated software is put into use. It is the Contractor's responsibility to have the system back online prior to the start of revenue service.
- J. Contractor shall adhere to Technical Specification TS 79 and RFP 10.21 Software Configuration Control requirements and standards.
- K. The Contractor shall provide all configuration/setup/programming of new and existing video system components identified in this specification section for a complete working system. Device configuration settings shall be submitted to the Engineer and the MBTA for approval prior to installation.
- L. The Contractor shall perform visual adjustments of each camera during installation to account for lighting conditions, desired view, and other environmental conditions.
- M. The Contractor shall have present during the duration of the Contract a certified network engineer with a minimum of 5 years' experience in networking of large-scale wide area network projects to be involved with all aspects of system integration of networked devices. The Contractor must submit this key person's resume with their RFP Technical Response. The Contractor's proposed certified network engineer will be subject to Authority review and approval. No work shall be allowed to proceed with components having a network interface if this key person is not involved. This person shall be on-site at all times when network integration is taking place. Failure to have this person on-site shall cause the MBTA to immediately stop work until this person is on-site, at the Contractor's expense. Shall this person no longer work for the Contractor, the Contractor shall immediately inform the MBTA and a replacement shall be submitted at that time.

- N. The Contractor shall have on site a person who is certified by the manufacturer of the individual subsystems (NVR, Wireless Access Point, and Genetec) for all work on these systems. The Contractor must submit each person's resume for approval by the MBTA within 10 days from Notice to Proceed. No work shall be allowed to proceed on these systems if a certified person is not involved. This person shall be on-site at all times when work on these systems is taking place. Failure to have this person on-site shall cause the MBTA to immediately stop work until this person is on-site, at the Contractor's expense. Shall this person no longer work for the Contractor, the Contractor shall immediately inform the MBTA and a replacement shall be submitted at that time.
- O. All Licenses and associated hardware necessary for the Genetec platform and any other integration, including MBTA existing Radio and CAD/AVL system connectivity, shall be supplied by the Contractor for all CCTV, or other installed equipment, and for existing equipment as described in these specifications.
- P. The Contractor shall coordinate SNMP Community Strings for all SNMP capable devices with the MBTA. The Contractor shall configure the Community String in all SNMP capable devices prior to deploying in the field. Any improper configurations shall be the sole responsibility of the Contractor to correct and shall be corrected within 48 hours of notification

1.2 SUBMITTALS

- A. All Contractor Submittals shall follow Technical Specification Design Review Schedule, and CDR and DRS requirements
- B. Prior to approval of the system hardware and software components, the Contractor shall submit the proposed equipment vendors qualifications and a written statement from the vendors acknowledging that the hardware and software to be supplied shall meet all functionality as required within this specification.
- C. The Contractor shall submit a typical block diagram indicating hardware and software components that shall be installed within each bus.
- D. The Contractor and vendor shall be prepared to demonstrate the equipment functionality within two weeks of submission and prior to vendor/equipment approval. The Contractor shall plan to demonstrate how this proposed equipment meets, or exceeds, all functional/performance requirements of the proposed vendor solution.
- E. The Contractor shall demonstrate to the Engineer the offloading capabilities of the system. This demonstration shall take place at a location in the metro Boston area.
- F. Submit descriptive literature, including manufacturer specification sheets, for all CCTV equipment and software functionality and materials proposed for use in accordance with the requirements of this Section for approval prior to fabrication, assembly, installation and testing.
- G. Also, submit the following to the Engineer for approval: Network diagram of complete system, illustrating proposed configuration and interconnections. The Network diagram shall include detailed network architecture of all related IP devices, IP schema, device bandwidth, configuration, and routing requirements.

- H. Prior to ordering any equipment as required under this Section, submit three (3) copies of the following to the Engineer for approval:
1. Full technical data and manufacturer cut sheets for all equipment.
 2. Site specific plans showing details of the following:
 - a. All Camera enclosure locations and mounting details.
 - b. Cable and conduit details.
 - c. Light intensity ranges throughout the interior of the bus (determined by actual field tests).
 - d. All Cameras field of vision.
 - 1) Submit schematic and wiring diagrams complete with terminal numbers.
 - 2) Submit NVR storage recording calculations, in days and hours.
 - 3) Submit procedures for programming and troubleshooting.
 - 4) Submit full interconnect diagram for overall system, including interface connections to existing equipment.
 - 5) Submit configuration plan for camera/NVR access levels.
- I. Supply maintenance instruction manuals to the Engineer including information regarding installation and maintenance as follows:
1. Operational Description and Procedures
 2. Troubleshooting and Routine Test Procedures
 3. Adjustments and Alignment Procedures
 4. Wiring Diagrams, Tables and Schematics
- J. Prior to installing any equipment, submit to the Engineer for approval three (3) copies of a detailed field test procedure intended to ensure all components of the system are functioning properly, in accordance with these Specifications. The tests performed shall include the tests outlined in Paragraph 3.3 of this Section. The detailed test procedure shall include a description of all test equipment to be used and specific measurements and/or pass/fail criteria for each test.
- K. Factory Tests: In the Contractor's shop, the Contractor shall install all software and configure all equipment to be installed on the bus and test the system prior to installation on the bus. The Contractor shall submit a sample factory test report for approval prior to beginning installations on the buses. The factory test report shall include IP addresses, software and firmware revisions, part numbers, and serial numbers of the equipment tested and to be installed.
- L. Test Procedures and Reports: Full details shall be submitted of the scheduled tests and the expected duration of all test procedures. Samples of all test report forms, and full details of the methods that the raw test data is to be reduced, shall be approved by the MBTA before commencement of system testing to be furnished under this Contract.
1. The test report shall identify the name of manufacturer, model numbers, serial numbers, and the last date of calibration of test instrumentation. Documentation shall be furnished to verify that test instruments have been calibrated not more than nine months prior to the tests. If a test instrument does not require calibration, it shall be highlighted in the report.
 2. The test report shall include a list of attendees.

3. Certified test results for the system components tests shall be submitted within 30 days after the completion of each test. No equipment shall be released for shipment until certified test data is approved by the Authority. Copies of approved test procedures, raw data measured results, calculations and all data derived from tests shall be included as part of report. All test data shall be bound in one report. The test report shall be indexed and cross-referenced in an easily understood manner.
- M. Certificate of Compliance: Submit a certificate of compliance that all components furnished meet the requirements specified herein.
- N. Operation and Maintenance Manuals shall be submitted as listed below:
1. The Contractor shall furnish an operation and maintenance manual for each piece of equipment, unless otherwise specified herein. The manual shall be provided in both hardcopy and on compact disk. The MBTA Vehicle Engineering Department, prior to submittal, shall approve the software utilized. The following identification shall be inscribed on the cover: the words "OPERATING AND MAINTENANCE MANUAL", the name and location of the project, the name of the Contractor, the contract number, revision, and date. The manual shall include the names, addresses, and telephone numbers of each subcontractor furnishing or installing equipment. In addition, include the local representatives for each item of equipment. The manual shall have a table of contents and index. The manual shall be assembled to conform to the table of contents, including tab sheets placed before instructions covering the subject. The instruction sheets shall be legible with large sheets of drawings folded in. The contents of the manual shall also be available on-line by means of a help screens.
 2. The Contractor shall submit to the Engineer for approval three (3) copies of the preliminary operation and maintenance manual at least 30 days prior to shipment of first relevant unit. After approval of the preliminary submittal and having made all necessary corrections and amendments as required, the Contractor shall supply the Engineer with six additional copies of the approved dated operation and maintenance manuals. One set of master camera-ready copy shall be included as one of the six copies to permit additional copies to be made. The master camera-ready copy shall be clearly marked as such on the outside. One manual shall be provided on compact disk. The MBTA Communications Department, prior to submittal, shall approve the software utilized. The manual shall provide a clear explanation of the theory, operation, and maintenance of the equipment accompanied by photos and schematic, wiring and mechanical assembly diagrams, as required. The manual shall be indexed and cross-referenced in an easily understood manner. The manual shall be loose leaf bound and shall include the following information:
 - a. Operating instructions.
 - b. Troubleshooting and fault isolation procedures for on-site level repair.
 - c. System equipment removal and replacement procedures.
 - d. A list of the replaceable components with images and part numbers.
 - e. A test procedure to verify the adequacy of repair work.
 - f. A preventive maintenance schedule and instructions for the replacement of any equipment.
 - g. A preventive maintenance schedule for inspection, removal, and replacement for each component.
 - h. A list of special tools provided by the manufacturer.
 - i. A list of recommended tools and test equipment as required for performing all maintenance tasks.
 - j. Recommended spare parts list for one year's operation.

- k. Interchangeable parts list-showing parts common to items of equipment.
- l. Equipment manufacturers' descriptive literature including catalog cut sheets.
- m. As-built working drawings.
- n. System component approved factory test reports.
- o. The latest service bulletins with dates that describe service procedures.
- p. Camera configuration, troubleshooting, fault diagnostics and default settings.
- q. The NVR software programming, troubleshooting, fault diagnostics, and shutdown procedures.
- r. All software screens to be utilized for graphic representation of physical locations of equipment installation.
- s. Update Operations Manual for CCTV system software modifications provided under this Contract.

1.3 REGULATORY REQUIREMENTS

- A. Comply with all applicable requirements of the following:
 - 1. National Electrical Code
 - 2. Massachusetts Electrical Code
 - 3. TIA
 - 4. IEEE
 - 5. ANSI
 - 6. ETL
 - 7. FCC
 - 8. ISO
 - 9. UL
 - 10. IEC
 - 11. RoHS
 - 12. SAE

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Furnish all items of the material, design, sizes, and ratings specified herein.
- B. All CCTV cameras, and NVRs installed under this contract shall be integrated and fully functional with the Genetec software and the integration shall be approved by the Authority. If the Contractor wishes to use a CCTV camera that meets the specifications and is not currently integrated with Genetec Security Center, then they must have the camera integrated and the integration approved by Genetec at no additional cost to the contract, and without any contract time extension.
- C. Any camera, NVR or software installed under this contract must support a non-proprietary, open architecture platform which is fully ONVIF profile S and G compliant and must have been granted the SAFETY Act Designation and Certification by the U.S Department of Homeland Security (DHS). Video management software must also be currently listed on DHS website at the time of bid.
- D. The Contractor is responsible for providing all software and licensing necessary for achieving the described functionality.

- E. All firmware and software shall be updated to the newest version prior to the close of the project.
- F. All software and hardware manufacturers shall have permanent representation and support within the United States.
- G. All equipment installed on the buses shall pass MIL-STD-810 Test Methodology 514.6 Tests I and III for vibration and 516.6 Test I for shock or an equivalent test, acceptable to the MBTA for functional vibration and shock in the environment in which the equipment will be used.
- H. All equipment shall be mounted with tamper-proof stainless-steel hardware and thread lock shall be used to securely hold fasteners. All connections shall use a gasket or sealant where needed and as described herein. The Contractor shall submit a drawing of the mounting of all equipment for approval by the MBTA prior to installation on the first bus.
- I. The Contractor shall wire the covert switch on the bus to also act as a trigger to the On- Bus NVR to create an alarm in the core MBTA directories.
- J. When the operator is not seated and the parking brake is released, and ignition/propulsion is either on or off, an alarm and audible annunciation warning message shall be activated. These events shall be broadcast on the VLAN to trigger a video record event five (5) minutes before and after the event. (TS 40.6 and TS 76.6)

2.2 MATERIAL

- A. All material shall be new and unused commercial off the shelf products and the workmanship shall be in accordance with the highest standards of the electronic equipment industry. Bids will be accepted only for new and current equipment. Equipment discontinued by the manufacturer shall not be accepted. All components shall be UL listed.
- B. Equipment purchased under this Section shall comply with applicable SAE and EIA standards, and the manufacturer's warranties against material and workmanship.
- C. Supply all equipment capable of meeting the performance requirements within the bus environment, subject to temperature, electromagnetic interference, humidity, vibration, power fluctuations, and light conditions typically encountered.

2.3 MANUFACTURER/CONTRACTOR EXPERIENCE

- A. Manufacturers supplying mobile IP video recording equipment shall have a minimum 5-years' experience in the IP video market. Manufacturer shall have experience in design and implementation of mobile systems of this size and complexity.
- B. Upon award of Contract, the manufacturer shall agree to support all installed equipment for a minimum 14-years after system acceptance. This shall be submitted in a formal letter to the MBTA Project Manager from the manufacturer.
- C. Upon award of Contract, the manufacturer shall agree to support all software for a minimum 14-years after system acceptance per the requirements of Technical Specification Section TS 80 Software Escrow. This shall be submitted in a formal letter to the MBTA Project Manager from the manufacturer.
- D. The Contractor installing the IP video equipment must have experience in IP video technology and must have prior experience in implementing an IP video network of similar complexity and size.

- E. All equipment used on the buses shall be service proven, and the Contractor shall include two references that the MBTA can contact regarding the success of the equipment or software.

2.4 CCTV CAMERA MOUNTS

- A. All CCTV camera mounts shall be designed by the manufacturer for the sole purpose of mounting the CCTV camera to a vehicle.
- B. All CCTV camera mounts shall be type as stated herein. All mounting hardware shall be stainless steel, and be of tamper proof design. The Contractor shall provide six tamper proof screw drivers upon the acceptance of the first bus.
- C. The Contractor shall apply thread lock to all mounting hardware.
- D. All CCTV camera mounts shall match the color of the CCTV Camera housing to which it is attached.
- E. Any non-standard camera mount must be submitted for approval.
- F. The Contractor shall submit mounting details for approval by the MBTA including all components, sealants, and mounting hardware.

2.5 FIXED IP 360° CCTV CAMERA

A minimum of (3) three 360 Degree IP Cameras shall be installed. Mounting locations will be finalized during design review. The 360 Degree IP Cameras to be provided under this Section shall meet, or exceed, the following requirements:

- A. The 360 Degree IP Camera shall be certified by the manufacturer to be fully compatible with the Network Video Recorder specified elsewhere in the section.
- B. The 360 Degree IP Camera shall be of a day/night (color/B&W) type with automatically removable infrared cut filter for viewing scenes at low light levels unless the 360 Degree IP CCTV Camera meets the black & white illumination requirements while still in color mode.
- C. The 360 Degree IP Camera shall output multiple video streams using different codecs simultaneously.
- D. The 360 Degree IP Camera shall stream both H.265 and H.264, minimum.
- E. The 360 Degree IP Camera shall include a Web User Interface.
- F. Any digital Pan/Tilt/Zoom functions shall be limited to login or other authentication means, such that the dedicated fields of view cannot be inadvertently changed through the software interface.
- G. The 360 Degree IP Camera shall be ONVIF conformant.
- H. The 360 Degree IP Camera shall have enough dynamic range to compensate for the wide range of ambient lighting conditions, including the difference between daylight flooding through vehicle windows and the interior lighting conditions that will be encountered in a bus environment while still providing usable images.
- I. The Contractor shall provide, and install, all required camera mounting brackets, adapters and associated hardware to mount the 360 Degree IP Cameras at the locations as approved by the Authority.

- J. General Construction
 - 1. Impact resistant housing, IK10, minimum
 - 2. Clear polycarbonate dome
 - 3. Tamper and impact resistant CCTV Camera assembly
- K. Electrical
 - 1. M12 connector for 100Base-TX Ethernet.
 - 2. Input voltage: PoE (IEEE 802.3af) Class 2, 9.5 watts at camera; maximum
 - 3. Network Link Indicator Light.
- L. Imaging System
 - 1. Imager: Single imager, 6MP or greater
 - 2. Iris Automatic iris control
 - 3. Imaging Sensor: 1/1.8" or greater
 - 4. Resolutions: Original: 2048x2048, 1280x1280, 1080x1080, 960x960
Single Panorama: 2048x512, 1920x480
Double Panorama: 2048x1024, 1920x960
Quad View: 2048x1536, 1600x1200, 1280x960
 - 5. S/N Ratio: 50dB
- M. Minimum Illumination (No Image Enhancement, AGC On, 30 FPS)
 - 1. Color: 0.1 Lux
 - 2. Black & White: 0 (IR LED On) Lux
- N. Dimensions:
 - 1. Diameter: 5.75", max
 - 2. Height: 2.59", max
- O. Camera Field of View
- P. Angular: H: 94.8° / V: 49.3° / D: 114.3°
- Q. The 360 Degree Camera assembly shall meet, or exceed, the following environmental requirements:
 - 1. Operating Temperature: -22°F to +131°F
 - 2. Environmental Rating: IP66
 - 3. Compliant with EN50155 Standard
- R. Networking Requirements:
 - 1. The 360 Degree IP Camera shall include Unicast and Multicast streaming.
 - 2. The 360 Degree IP Camera shall support the following protocols: TCP/IP, UDP/IP, IPv4, IPv6, HTTP, HTTPS, Unicast, Multicast (IGMP), UPnP, DNS, DHCP, ARP, FTP, RTP, and NTP.
 - 3. The 360 Degree IP Camera shall be password protected.
 - 4. The 360 Degree IP Camera shall be fully compatible with the Ethernet Switch, Network Video Recorder, and Genetec.

- 2.6** The Contractor is responsible for all 360 Degree IP Camera setting adjustments to be configured for the location and application. 360 Degree IP Camera adjustments shall include brightness, contrast, saturation, zoom level, focus, back light compensation, dynamic range, frame rate, and compression.

2.7 FIXED IP CCTV CAMERA

A minimum of (9) nine Fixed IP CCTV Cameras shall be installed. Mounting locations will be finalized during design review. The Fixed IP CCTV Cameras to be provided under this Section shall meet, or exceed, the following requirements:

- A. The Fixed IP Camera shall be certified by the manufacturer to be fully compatible with the Network Video Recorder specified elsewhere in the section.
- B. The Fixed IP Camera shall output multiple video streams using different codecs simultaneously.
- C. The Fixed IP Camera shall stream both H.265 and H.264, minimum.
- D. The Fixed IP Camera shall include a Web User Interface.
- E. The Fixed IP Camera shall be ONVIF conformant.
- F. The Fixed IP Camera shall have enough dynamic range to compensate for the wide range of ambient lighting conditions, including the difference between daylight flooding through vehicle windows and the interior lighting conditions that will be encountered in a bus environment while still providing usable images.
- G. The Contractor shall provide and install all required camera mounting brackets, adapters and associated hardware to mount the Fixed IP Cameras at the location(s) as approved by the Authority.
- H. The Fixed IP Camera shall stream 60 FPS at 1920 x 1080 with H.265 encoding.
- I. The Fixed IP Camera shall simultaneously stream two 15 FPS multicast streams at 1920 x 1080 with H.265 encoding.
- J. General Construction
 - 1. Impact resistant housing, IK10, minimum
 - 2. Low profile housing with a clear polycarbonate dome to protect imager
 - 3. Tamper and impact resistant CCTV Camera assembly
- K. Electrical
 - 1. M12 connector for 100Base-TX Ethernet
 - 2. Input voltage: PoE (IEEE 802.3af) Class 1, 3.84 watts at camera; maximum
 - 3. Camera shall be fully operational within the Operating Temperature range listed

elsewhere in this specification on IEEE 802.3af PoE.

- L. Imaging System
 - 1. Iris Automatic iris control
 - 2. Imaging Sensor: 1/2.8"
 - 3. Image Resolution: 1080p (1920 x 1080, 30 FPS), minimum
 - 4. Lens: 102-degree horizontal field of view
 - 5. Dynamic Range: 120dB
- M. Minimum Illumination (No Image Enhancement, AGC On, 30 FPS)
 - 1. Color: 0.04 Lux (F2.0)
 - B&W: 0 Lux (IR LED On)
- N. Camera Angle Adjustment: H: 94.8° / V: 49.3° / D: 114.3
- O. Dimensions:
 - 1. Length: 4", max
 - 2. Width 4", max
 - 3. Height: 2.25", max
- P. The Fixed IP Camera assembly shall meet or exceed the following environmental requirements:
 - 1. Operating Temperature -22°F to +131°F
 - 2. Environmental Rating IP66
 - 3. Compliant with EN50155 Standard
- Q. Networking Requirements:
 - 1. The Fixed IP Camera shall include Unicast and Multicast streaming.
 - 2. The Fixed IP Camera shall support the following protocols: TCP/IP, UDP/IP, IPv4, IPv6, HTTP, HTTPS, Unicast, Multicast (IGMP), UPnP, DNS, DHCP, ARP, FTP, RTP, and NTP.
 - 3. The Fixed IP Camera shall be password protected.
 - 4. The Fixed IP Camera shall be fully compatible with the Ethernet Switch, Network Video Recorder, and Genetec.

2.8 The Contractor is responsible for all Fixed IP Camera setting adjustments to be configured for the location and application. Fixed IP Camera adjustments shall include: pan and tilt orientation, brightness, contrast, saturation, focus, back light compensation, dynamic range, frame rate, and compression.

2.9 CAMERA SHROUD

- A. The Contractor shall provide a camera shroud for each of the exterior cameras. The shroud shall protect the exterior cameras from being damaged by the bus wash system, passing branches, vandalism, etc., without hindering the camera view.
- B. The shroud shall be fabricated from a single sheet of one-sixteenth inch (1/16") thick stainless steel, painted to match the exterior of the bus.
- C. The shroud shall include pre-drilled holes around the perimeter for fastening hardware.
- D. The Shroud shall not have any adhesives, or in any way damage the bus when removed for camera maintenance.

2.10 ON-BUS NETWORK VIDEO RECORDER (NVR) HARDWARE

- A. The On-Bus Network Video Recorder Hardware and Mobile Network Video Recorder Software shall be selected to complement each other in order to achieve the requirements included in these specifications. If a specific feature is not required in this section, but is required for the NVR Software to meet the required functions, then that feature shall be included by the Contractor at no additional cost to the contract. If the achievement of the system and software requirements by the software chosen by the Contractor requires an enhancement of any specification, then those enhanced specifications shall be included at no additional cost to the contract.
- B. The On-Bus NVR shall meet, or exceed, the following specifications:
1. CPU: Intel i7-7600u, newest version, 2.8GHz, minimum
 2. Memory: 32GB DDR3-1600, minimum
 3. USB: (1) USB 2.0, minimum
 4. Audio: (1) Audio Input, minimum
 5. Storage: OS: 128G SATA III, SSD
Data: 4TB, 2.5" SATA 6.0Gbps 5400RPM
 6. Display Output: DVI or VGA with resolution of 1600x1200
 7. Ethernet: (8) 10/100/1000Base-T with M12 connector
 8. Ethernet Wireless 802.11a/b/g module
 9. 5G Wireless Certified Verizon Wireless 5G built-in module
 10. Inputs: (8) Dry Contact, minimum
 11. Outputs: (2) Digital, 200mA maximum
 12. Status LEDs: Power, Storage, LAN
 13. Dimensions: 11.5"x11.5"x5", maximum
 14. Weight: 15 lbs, maximum
 15. Mounting: Panel
 16. Operating Temperature: -22°F to +122°F
 17. Cooling: Fanless
 18. Relative Humidity: 10 to 90% non-condensing
 19. Voltage: 12 – 36 VDC
 20. Power Consumption: 80 Watts, maximum
 21. Standards: UL 60950-1, EN 50155
 22. Windows 10 IoT Enterprise, 64Bit
- C. The On-Bus NVR shall contain up to two video storage drives installed on trays that can be removed by the user without any dismantling of the On-Bus NVR. The video storage drive trays shall be visible on the front of the On-Bus NVR, shall require a vandal proof/tamper proof key be turned on the On-Bus NVR prior to drive removal, and, after turning of the key, shall permit the drive tray to be simply pulled to remove the drive. These hard drives can then be placed in a Hard Drive Dock for access to the video. A new drive or drives can then be installed in the On-

Bus NVR and no other initialization shall be required for the NVR to function upon ignition of the bus. The video storage hard drives shall be sized to record all CCTV Camera views for 170 hours.

- D. The On-Bus NVR shall include a solid-state storage device that is removable by opening of the On-Bus NVR that contains the operating system and the Mobile NVR Software. This solid-state storage device shall not be removed when the video drives are removed for evidentiary research, storage, or other reasons.

2.11 MOBILE NVR SOFTWARE

- A. The Mobile NVR Software shall be installed on the On-Bus Network Video Recorder to record the streams from Fixed IP CCTV Cameras and 360 Degree IP CCTV Cameras. The Mobile NVR Software shall also connect to the NVRs located at the two MBTA Data Centers within Boston, MA and installed on the Stationary Recording Hardware for the purpose of offloading tagged event video, requested video, and equipment status and failures. Events shall be tagged when any selected digital input to the On-Bus Network Video Recorder is activated.
- B. The NVR software installed on the Stationary Recording Hardware shall allow for the connection of clients on the SWAN to access the video offloaded from any bus at any time they are on the MBTA SWAN. The software shall also allow the connection of a client on the SWAN to the live and recorded video on any bus connected to the Fixed Wireless Network. The software shall also allow any client on the SWAN to select a period of time for any bus on or off the Fixed Wireless Network for automatic offloading next time the bus is connected to the Fixed Wireless Network. The clients shall also be able to check the health status of any On-Bus NVR connected or disconnected from the Fixed Wireless Network. The client software shall alert the user of any critical On-Bus NVR problems upon login.
- C. The Mobile NVR Software shall record the streams from all cameras using H.265 at 10FPS, for seven days and overwrite the oldest data when full.
- D. The Mobile NVR Software shall also be capable of recording the audio stream along with any video stream from a camera.
- E. When the bus enters the yard and connects to the Fixed Wireless Network, the video from any tagged events and any video requested by a client on the MBTA SWAN shall be offloaded from the On-Bus NVR. If the wireless connection is interrupted, then offload shall halt and continue without error upon reconnection to the Fixed Wireless Network.
- F. The Mobile NVR Software shall operate on a First In, First Out manner; the first video recorded shall be the first overwritten once the hard drives are full.
- G. On ignition, the Mobile Closed Circuit Television System shall activate. The NVR shall be fully booted and active with two (2) minutes of ignition. The On-Bus NVR shall begin recording video once it has fully booted. On loss of ignition, the Mobile Closed Circuit Television System shall remain active for nine (9) minutes. The On-Bus NVR shall continue to record cameras for these nine (9) minutes, and, if a connection to the Fixed Wireless Network is active, shall offload video. After nine (9) minutes, all components shall shut down unless the ignition is again turned on prior to shut down.

2.12 DIAGNOSTIC MONITORING

- A. The Contractor shall include a method of performing remote diagnostic testing of the On-Bus Network Video Recorder, On-Bus Cameras, On-Bus PoE Switch, and On-Bus Wireless Access Point. The tool shall include the date, time, health status, GPS location, vehicle location, last status, clock sync and system versioning information. This includes all tools and instructions for performing the diagnostics.
- B. The contractor shall include a method of monitoring the following vehicle indication points onto the NVR utilizing the 8 contact positions.
 - 1. Left Turn Signal (On or Off)
 - 2. Right Turn Signal (On or Off)
 - 3. Door Open/Closed (Collective All Doors)
 - 4. Driver Windshield Wipers (On or Off)
 - 5. Wheelchair Lift (Up or Down)

These points shall be integrated into the NVR and available with overlay or in separate window while viewing live or recorded video to give operators situational awareness of the vehicle mechanics as it relates to incident review. This point status and changes shall be logged into the local database and be treated as stored metadata. The MBTA shall have the discretion to add or remove indication points based on operational or security requirements as it sees fit for no additional cost in hardware or software.

- C. The Contractor's tool shall provide a method to remotely view all diagnostic information related to the On-Bus CCTV Systems in real time when available.
- D. The Contractor shall include in the tool a means for remotely rebooting or resetting all components of the On-Bus CCTV system.
- E. Each bus in the tool shall contain a camera list, systems health checks and reboot options and be included in a tree format.
- F. On booting, the On-Bus NVR shall display diagnostic information on the On-Bus Hardened 19" and 12" LCD Monitors when booting including but not limited to:
 - 1. The status and condition of the RAM
 - 2. The status and condition of the Hard Drives
 - 3. The status of the cameras
 - 4. The network status

2.13 TRI-COLOR REMOTE LED INDICATOR LIGHT

- A. The Tri-Color Remote LED Indicator Light shall be installed in the driver side dash panel and will show no color when the NVR is off, Red while the NVR is booting and when there is trouble, Amber when the NVR recording, but one or more cameras are defective, and Green when the system is operational and all the cameras are recording.
- B. The Tri-Color LED Indicator Light shall meet, or exceed, the following specifications:
1. Colors: Green, Red, Amber (Amber created by the energizing of both the red and green diodes)
 2. Voltage: 24VDC, or as required by the NVR
 3. Operating Temperature: -67°F to +158°F
 4. Environmental Rating: IP67
 5. Enclosure Material: Black Chrome-Plated Brass
 6. Dimensions: 42mm length, 9.5mm diameter reflector face
 7. Mounting: Stainless Steel Panel Mount
 8. Mounting Hole: 8mm

2.14 ON-BUS WIRELESS ACCESS POINT (WAP)

- A. The On-Bus Wireless Access Point shall be installed in each bus to automatically connect to the Fixed Wireless Network in client mode when in range in order to offload diagnostic information and tagged or requested video. The On-Bus Wireless Access Point shall also connect to the MBTA Police Mobile Data Terminals and Mobile Chase Briefcases to allow the MBTA Police to view live and recorded video from the bus when the bus is outside of the yard. The On-Bus WAP may also be integrated together with the On-Bus 5G LTE Gateway. All data shall pass to the SWAN over the On-Bus Wireless Access Point to the Fixed Wireless Network when the bus is within range of the Fixed Wireless Network. The On-Bus Wireless Access Points shall not broadcast the buses SSID. The On-Bus Wireless Access Point shall broadcast and transmit utilizing multiple spatial streams and a MIMO antenna system.
- B. The On-Bus WAP shall meet, or exceed, the following specifications:
1. Standards: 802.11a/b/g/n/ac, 802.11i, 802.3af, 802.1D, 802.1w, 802.1Q, IGMP, RADIUS, SNMP, DHCP, SNTP, TCP, UDP, DNS, HTTP, HTTPS
 2. Wireless Throughput: Up to 1300 Mbps
 3. Antenna Connections: Two (minimum)
 4. Operating Frequency: 5.2 to 5.8 GHz, all channels
 5. Security: MAC, IP, Protocol, and Port based filtering
 6. Access Management: RADIUS
 7. Encryption: WEP, WPA, WPA2 Personal, WPA2 Enterprise (TKIP and AES)
 8. Ethernet Connector: 10/100/1000Base-T M12

9. Status LEDs: WLAN, LAN, Power
10. Dimensions: 2.5" X 5.5" X 4.5" (approximate)
11. Weight: 4 lbs, maximum
12. Mounting: Panel or DIN Rail
13. Operating Temperature: -40°F to +167°F
14. Relative Humidity: 5 to 95% non-condensing
15. Voltage: 24VDC
16. Power Consumption: 15 Watts, maximum
17. Standards: UL 60950-1, EN 50155
18. MTBF: 350,000 Hours

- C. The On-Bus Wireless Access Point shall include an embedded GPS Receiver with high sensitivity using the NMEA protocol. The On-Bus Wireless Access Point shall allow connections to be made to request GPS location of the vehicle via the cellular network and wireless network.

2.15 ON-BUS 5G NR GATEWAY

- A. The On-Bus 5G NR Gateway shall provide the MBTA Operations, MBTA Police and MBTA Security Staff access to live and recorded video from the fleet vehicles via the Verizon 5G Wireless Network. The 5G Gateway shall be the primary interface point for all live, recorded and offloading services into the MBTA core video surveillance systems.
- B. The On-Bus 5G NR Gateway shall meet, or exceed, the following specifications:
1. Security Features: IP filtering, stateful firewall, custom firewall rules (iptables), address and port translation; Authentication: RADIUS, TACACS+; certificates; MAC address filtering; VLAN support
 2. Bands: 5G Sub-6 GHZ with 4G LTE and 3G Fallback - Worldwide
 3. 5G SIM Interface: 2 Mini-SIM (2FF)
 4. Ethernet Interface: (4) 10/100/1000 Base-T with M12X-CODE connectors
 5. Wireless Interface: Dual WiFi Modules – 2x2 MU-MIMO 5GHz 802.11a/n/ac Wave 2, 867 Mbps (Max) and 2x2 MIMO 2.4/5 GHz 802.11a/b/g/n/ac
 6. Verizon Antenna Interface: Four 50 ohm TNC (Center pin: Female)
 7. Shock / Vibration: MIL-STD-810G Vibration (Method 414.6C-10, Category 11), Shock (Method 516.6, Procedure I)
 8. Certifications: Verizon Wireless
 9. GNSS: Untethered Dead Reckoning using inertial sensors (accelerometer, gyroscope); multi-constellation (GPS, Galileo, GLONASS, BeiDou)
 - a. Sensitivity: -163dB
 - b. Protocol: NMEA 0183 V2.3 sentence output

- c. Connector: (1) 50 Ω RP-TNC (center pin: female); +3.3 VDC active antenna drive
- 9. Memory: 2GB RAM, Flash 8GB (CFAST card)
- 10. Dimensions: 10.2 in x 7.8 in x 2 in
- 11. Enclosure: IP66 aluminum alloy
- 12. Power: 9-36VDC, 60W minimum
- 13. Warranty: Manufacturer 3 year on hardware and software

2.16 ON-BUS POE SWITCH

- A. The On-Bus PoE Switch shall be installed on the bus to connect to the CCTV Cameras, On-Bus Wireless Access Point, On-Bus Network Video Recorder, and any other equipment that needs to communicate via Ethernet. The On-Bus PoE Switch shall also provide PoE Power to the CCTV Cameras.
- B. The On-Bus PoE Switch installed under this section shall meet or exceed the following criteria:
 - 1. The On-Bus PoE Switch ports shall include the following. (The Contractor shall include additional ports as necessary for a fully functional system based on chosen system components.)
 - a. Minimum (8) auto sensing 10/100 PoE ports
 - 1) Minimum (2) auto sensing 10/100 non-PoE ports
 - b. Connector: M12
 - 2. The On-Bus PoE Switch shall meet the following environmental requirements:
 - a. -40°C to +75°C
 - b. Operating relative humidity: 5% to 95% non-condensing
 - 3. The On-Bus PoE Switch shall meet the following electrical requirements:
 - a. Voltage: 24 VDC
 - 4. The On-Bus PoE Switch shall comply with the following standards:
 - a. UL 508
 - b. EN 50155
 - 5. The On-Bus PoE Switch shall meet HTML and Telnet management standards
 - 6. The On-Bus PoE Switch shall meet SNMP v1/v2/v3 network management standards
 - 7. The On-Bus PoE Switch shall use the following IP Multicast Standards:
 - a. IGMPv1, IGMPv2
 - 8. The On-Bus PoE Switch shall have the following security features:
 - a. IEEE 802.1X Port Based Network Access Control
 - b. TACACS+
 - c. SSH
 - 9. The On-Bus PoE Switch shall meet, or exceed, the following protocols and industry standards:
 - a. IEEE 802.3af Power over Ethernet
 - b. IEEE 802.1p Priority

- c. IEEE 802.1Q VLANs
 - d. IEEE 802.1w Rapid Reconfiguration of Spanning Tree
 - e. IEEE 802.3 10BaseT
 - f. IEEE 802.3u 100BaseT(X)
 - g. IEEE 802.3ab 1000BaseT(X)
 - h. IEEE 802.3x Flow Control
- 10. Mounting: Panel Mount
 - 11. Maximum Dimensions: 7" width x 7" height x 5" depth
 - 12. Warranty: 5 Years

2.17 ON-BUS WIRELESS ANTENNA

- A. An On-Bus Wireless Antenna shall be a multi-band, MIMO, multi-element antenna system, under a single radome. The antenna shall be designed for vehicular applications and be connected to the On-Bus Wireless Access Point and the On-Bus 5G LTE gateway, to transmit and receive wireless signals from the Fixed Wireless Network, a 5G cellular network, and MBTA Police Mobile Data Terminals. The antenna shall also have an element for GPS. The On-Bus Wireless Antenna shall have sufficient cable whips with low loss cable to reach from the installation location to the location of the On-Bus Wireless Access Point and On-Bus 5G LTE Gateway.
- B. The On-Bus Wireless Antenna shall meet or exceed the following specifications:
 - 1. Frequency Range (Voice/Data): 698-2500MHz and 3300-3800MHz
 - 2. Frequency Range (Wireless): 1.7-2.8 GHz and 4.9-5.9 GHz
 - 3. Frequency Range (GPS): 1575.42 MHz
 - 4. Antenna Gain (Voice/Data): 1-2 dBi at 698-2500MHz and 2-3 dBi at 3300-3800MHz
 - 5. Antenna Gain (Wireless): 2-3 dBi at 1.7-2.8 GHz and 3-4 dBi at 4.9-5.9 GHz
 - 6. Number of Elements: Five (minimum)
 - 7. Polarization: Linear, Vertical
 - 8. Impedance: 50 Ohms
 - 9. Input Power: 50 Watts, max
 - 10. Radome: Black, UV Protected
 - 11. Operating Temperature: -40°C to +85°C
 - 12. Connectors: SMA Plug
 - 13. Standards: IP67 Compliant

2.18 ON-BUS HARDENED 19" LCD MONITOR

- A. Two On-Bus Hardened LCD Monitors (one 19" and one 12") shall be installed to alert passengers that they are being recorded and shall display four (4) live CCTV Cameras views preselected by the MBTA using the NVR software. This view shall automatically launch after boot-up of the On-Bus NVR and shall be remotely configurable. The Contractor shall, utilizing tamper proof

hardware, surface mount the On-Bus Hardened 19" LCD Monitor on the rear of the equipment cabinet and the 12" LCD Monitor above the operator, in a manner as approved by the Authority. Route all cabling and connectors such that they are not exposed.

B. The On-Bus Hardened LCD Monitors shall meet, or exceed, the following specifications:

1. LCD Monitor Size 19" Diagonal display / 12" Diagonal display
2. Display Output VGA output will be a 800 x 600 on 12" display
DVI output will be a 640 x 512 in quad view on 19" display
3. Aspect Ratio 5:4
4. Response Rate 5ms, maximum
5. Power Consumption 25 Watts, maximum
6. Voltage 24 VDC
7. Enclosure Depth 2.4" maximum
8. Viewing Angle (Hor/Vert) 170° / 160°
9. Temperature Rating 32°F to 122°F
10. Shock/Vibration rating Mil-Spec 810, minimum
11. Enclosure Ratings: NEMA 4X, IP66
12. Enclosure Material: Stainless Steel
13. Screen Material: Safety Glass
14. Mounting: Surface Mount
15. Standards: UL 60950, UL 508A

2.19 ON-BUS UPS

A. An On-Bus UPS shall be installed to power the On-Bus NVR, On-Bus Wireless Access Point, and On-Bus PoE Switch. The On-Bus UPS shall be designed to filter power to attached devices and provide backup power when the bus is powered down.

1. Maximum Output: 15 Amps
2. Output Voltage: 27.6 to 29.6 VDC nominal
3. Backup Time: 15 Minutes @ 8 Amps, 8 Minutes @ 12 Amps
4. Battery Amp-Hour Rating: 5
5. Battery Life: 5 Years
6. Voltage Spike Protection: 4,000 Amps, 100 Joules
7. Indicator Lights: LED to indicate status of input and output power
8. Dimensions: 6" x 7.75" x 7.5" (maximum)
9. Weight: 10 pounds, maximum

B. The On-Bus UPS shall include protection circuitry to avoid complete discharge of the battery.

2.20 TERMINAL BLOCKS AND POWER WIRING

- A. All power wiring shall be 14 AWG, stranded wire suitable for automotive installations.
- B. All wiring shall adhere to the requirements of Technical Specification TS 34 and TS 35 as applicable
- C. Terminal Blocks shall be designed for use on moving vehicles, and shall be used for connections of power and control wiring on the bus.
- D. Terminal Blocks shall be DIN rail mounted.
- E. Provide DIN rails and end panels for each group of terminal blocks.
- F. All Terminal Blocks shall meet, or exceed, the following specifications:
 - 1. Dimensions: 0.25" x 2" x 1.5" maximum
 - 2. Maximum Load Current: 31 Amps
 - 3. Pollution Degree: 3
 - 4. Nominal Voltage: 800 Volts
 - 5. Nominal Current: 24 Amps
 - 6. Conductor Cross Section: 12-28 AWG
 - 7. Connection Type: Spring Cage
 - 8. Standards: EN 50155
 - 9. Temperature Rating: -50°C to +110°C

2.21 ON-BUS CATEGORY 6 (CAT6) CABLE

- A. All On-Bus CAT6 shall be suitable for indoor/outdoor use. The cable shall be rated for wet locations.
- B. All On-Bus CAT6 network cabling and connections shall be labeled at each end. All labels shall be shown on submitted shop drawings for type, location and service.
- C. All On-Bus CAT6 cables and components installed shall comply with the following:
 - 1. All CAT6 network cabling systems shall have EIA/TIA 568B Series standard pin/pair termination assignment. All conductors provided shall be properly and consistently terminated at both ends throughout the entire system. All Shields shall be connected on both ends of cables to facilitate proper grounding and drain.
 - 2. ANSI/TIA/EIA-568-B.2-1
 - 3. IEEE 802.3af DTE Power and MDI Verified
 - 4. IEEE 802.ab Gigabit Ethernet Verified for modem to NVR connectivity.
 - 5. IEEE 802.3u 10/100 Base TX verified for NVR to Camera connectivity.
 - 6. ETL Verified
 - 7. FCC part 68.5, subpart F compliant

8. ISO 11801 2nd Edition, Class E Compliant

D. Cable Physical Characteristics:

1. Jacket: Polyolefin
2. Jacket Color: Yellow / Green / Orange
3. Insulation: Polyolefin
4. Conductors: #24 AWG Solid Bare Copper, or larger
5. Shielding: Aluminum/Polyester with 100% coverage
6. Composition: 4 Pair, STP with Core Separator
7. Operating Temperature: -14°F to 167°F
8. Cable O.D. (Max): 0.25 inches
9. Voltage Rating: 300 Volts RMS
10. Flame Tests: UL1581 and UL1685

2.22 M12 END CONNECTORS

- A. M12 End Connectors shall be used to terminate On-Bus CAT6 Cables for connections to CCTV Cameras, On-Bus NVRs, On-Bus PoE Switches, and any other Ethernet Connected Device.
- A. The M12 End Connectors shall be designed to terminate the On-Bus Cat6 cables.
- B. The M12 End Connectors shall be a screw connections type for connection to the devices.
- C. The M12 End Connectors shall have an operating temperature of -40°F to 185°F.
- D. The M12 End Connectors shall be coded to match the devices they are attaching to for proper alignment of the connector.

2.23 HARD DRIVE DOCK

- A. The Contractor shall include four (4) Hard Drive Docks that shall accept the drives removed, by the MBTA Police or another approved person, from the On-Bus NVR. The Hard Drive Dock shall be stand alone with keyboard, mouse, and monitor, or a device that connects to another computer (the Contractor shall include four compatible computers with keyboard, mouse, and 23" 1920x1080 monitor if the hard drive dock requires it). The Hard Drive Dock shall accept the one or two drives from the On-Bus NVR and allow the user to insert the drives to search all video recorded on the drives.
- B. The MBTA shall be able to format NVR hard drives while connected to the Hard Drive Docks.

2.24 IP CCTV CAMERA SIGNAGE

- A. The IP CCTV Camera Signage shall be installed on each bus to alert the public that there are CCTV cameras recording on the bus. Signs shall be installed plumb, with no air bubbles.
- B. The IP CCTV Camera Signage shall meet requirements of TS Attachment 1

2.25 WORKSTATION INTERFACES AND SOFTWARE

- K. Certain features of the system shall be functional through both the NVR native client and the Genetec Security Center client. Administration and configuration features of the system are only required to be accessible from the NVR native client.
- L. The live video streaming from the bus, the recorded video stored on a bus, and the recorded video stored on MBTA Central storage shall be available for viewing through Genetec Security Desk. If the NVR is connected to the WiFi network or has 5G LTE activated and is connected to the 5G LTE network, then the live video and the recorded video stored on the bus shall be accessible.
 - 1. In Genetec, if the user selects a camera for viewing that is not connected to the 5G LTE network or the WiFi network then it shall be reported to the user that the live video and the video stored on the bus is not accessible, and still allow the user to access video that is stored on the Stationary Recording Hardware. If the user is viewing a camera on an NVR connected to the WiFi or 5G LTE network and the NVR disconnects from the network, then it shall be reported to the user that the video is no longer available for viewing due to the NVR disconnecting.
 - 2. The NVR native client shall graphically show which cameras are connected to or disconnected from to the network and shall not allow the user to try to connect to live video or recorded video stored on a bus, but still allow the user to access recorded video stored on the Stationary Recording Hardware.
- M. Any critical alarm including, but not limited to, hard drive failures, failure to connect to the network for 24 hours, power failures, and RAM failure shall be reported from the software to Genetec for alarming. In the case of a bus with an active 5G LTE connection, alarms shall also be configurable if a system is offline for lesser periods of time. The software shall only issue one alarm through Genetec for a single event.
- N. From the NVR's Genetec System, the user shall have the ability to request time periods of video for offloading from the Mobile NVRs on the buses next entry onto the WiFi network. The selection of video shall not require the Mobile NVR to actively be connected to the network to initiate this request.
 - 1. When making a request for time periods of video to be offloaded, the person making the request shall have the option of entering their email address. Once the video is retrieved, the person making the request shall receive an email stating that the request has been fulfilled with the bus number and the time and date range of the request.
 - 2. The application shall give at least three statuses for requested video:
 - a. Sending of the request to the system is pending.
 - b. Request received by the system and awaiting fulfillment.
 - c. Request has been fulfilled.
- O. The NVR native client shall allow the user to view the health status of all NVRs including any critical errors or warnings and the last time any NVR connected to the system. Critical error

and warnings shall also be selectable for emailing to selected persons or groups.

2.26 LOCKABLE NVR BOX

- A. The Lockable NVR Box shall be used to house the On-Bus Network Video Recorder and protect it from tampering. The Lockable NVR Box can also be an integral part of the On-Bus NVR Hardware if it results in the intended functionality.
- B. The Lockable NVR Box shall meet, or exceed, the following specifications:
 - 1. Material: Brushed aluminum
 - 2. Material Thickness: 1/8", minimum
 - 3. Mounting: The Lockable NVR Box shall mount securely to the shelf, and the On-Bus NVR shall mount securely to the Lockable NVR Box.
 - 4. Size: Appropriately sized to allow the On-Bus NVR to fit, connections to be made, and the On-Bus NVR to cool properly
 - 5. Vents: Shall include sufficient vents or alignment of heat transfer fins or sinks to allow proper heat transfer
 - 6. Cable Entries: Shall include grommets and shall be sized appropriately for cables
 - 7. Locks: Tamper resistant, all keyed alike
 - 8. Keys: Include one key per box

2.27 SPARE PARTS

- A. The Contractor shall supply the following spare parts upon completion of the project. Quantity shall be derived from the quantity of buses outfitted with the Mobile Closed Circuit Television System.
 - 1. PoE Switch Power Supplies (3%)
 - 2. NVR (3%)
 - 3. UPS (3%)
 - 4. Terminal Blocks (3%)
 - 5. On-Bus NVR Hard Drives (100)
 - 6. 360 Degree IP Cameras (10%)
 - 7. Fixed IP Camera (10%)
 - 8. Interior forward facing camera mount (3%)
 - 9. MIMO Antenna and mount (3%)
 - 10. Mobile Wireless Access Point (3%)
 - 11. Tri-Color LED Indicator Light Assembly (10%)
 - 12. Monitor (3%)

PART 3 - EXECUTION

3.1 GENERAL

- A. Installation of all CCTV System equipment shall be in accordance with manufacturer's recommendations, approved shop drawings, and as shown on the Contract Drawings.
- B. All wiring shall be neatly installed and wire ways shall be utilized wherever possible. All wiring shall be identified at both ends by wire markers.
- C. Furnish and install a complete and operable CCTV System.
- D. The Contractor is responsible for system start-up, performance testing and network testing, and the installation of all required interconnections for a fully functional system.
- E. The Contractor is responsible for Incidentals and appurtenances necessary to complete the work as specified herein and as shown on the Contract Drawings.
- F. Contractor shall provide as-built drawings, and operation and maintenance manuals.

3.2 INSTALLATION

- G. Install CCTV cameras in locations with the orientations as approved by the Authority.
- H. All mounting hardware shall be stainless steel, and of tamper proof design.
- I. All penetrations through the bus shall be properly sealed.
- J. Install supporting equipment in the bus communication cabinet as shown on the Contract Drawings.
- K. Cabling to all CCTV cameras shall be CAT6 STP.
- L. No Ethernet connected device shall be installed until its cabling is properly labeled.

3.3 COMPONENT LABELING

- A. The Contractor shall label each CCTV component with an asset label.
 - 1. Durable (expected life greater than five years) asset labels shall be securely fixed to the device.
 - 2. Labels shall be black anodized color-in aluminum, treated with UV resistive black coloring.
 - 3. Labels shall be printed using the Boss Laser FM 20 metal laser marker.
 - 4. If the standard label media described above cannot be used, a suitable replacement can be used after review and approval by MBTA Engineering and Maintenance Department.
- B. The Contractor shall label each device with an asset label containing the information listed below. The Contractor shall submit an example label to the MBTA for approval prior to creating labels and labeling components.
 - 1. MBTA Logo

2. The vehicle number
 3. The device ID
 4. A unique QR code (35 x 35 pixel) of the device label information
- C. Labels shall be securely fixed to the asset, where they are visible while the asset is in operation and/or while being maintained. In some cases, multiple tags may be required. When attaching to assets of a certain type, labels must be attached in the same location on each asset.
- D. Attaching asset ID labels will be done using a long-lasting, quick drying, weather resistant adhesive. Prior to applying adhesive, the area where the label will be placed must be cleaned thoroughly to ensure proper bonding.

3.4 TESTING

- A. Conduct electrical tests to demonstrate compliance with this Specification and with manufacturer's recommended test procedures as approved by the Engineer.
- B. The Contractor shall supply all test equipment and software for all system tests. Test equipment shall have been calibrated within nine months of test.
- C. CAT6 cable shall be tested after termination to ensure that the cable was not damaged during pulling and that it was properly terminated. The Engineer reserves the right to attend, or send a representative to, any cable testing that is performed.
- D. A wiremap test shall be performed on all CAT6 cables with a commercial off the shelf wiremap tester. The wiremap test shall ensure continuity of wires, absence of shorts, grounding, or any other wire pulling or termination problems or errors.
1. Specification sheets of the wiremap tester and test procedure shall be submitted to the Engineer for approval prior to the beginning of testing.
 2. All tests shall be recorded with a description of which cable is being tested, a pass or fail, the reason for failure, the corrective action taken, the date, the time, and the technicians performing the test. Tests shall be re-run after the corrective action is taken. The test reports shall be submitted to the Engineer for approval.
- E. An Ethernet bandwidth test shall also be performed on all CAT6 cables with commercial off the shelf handheld Ethernet bandwidth testers that perform Y.1564 compliant tests at one Gigabit and 10/100Mbps. The Ethernet bandwidth tester shall also be capable of saving test reports to internal or removable storage to be printed or made into a PDF. The test setup shall use one tester on each end of the cable and shall test bi-directionally.
1. Specification sheets of the Ethernet bandwidth testers and test procedure shall be submitted to the Engineer for approval prior to the beginning of any testing.

2. All tests shall be recorded with a description of which cable is being tested, the cable length as measured by the Ethernet bandwidth testers, the measured bandwidth, the Bit Error Rate, the date, the time, and the technicians performing the test. The test reports shall be submitted to the Engineer for review.
- F. After each bus installation is complete, the Contractor shall verify proper operation of all system software control functions, camera views, and video streams as described herein, to test all functionality of the CCTV System. The Contractor shall develop and submit a test plan and check off sheet for review by the Engineer 30 days prior to testing the first bus, the test plan shall contain performance and failure testing of all levels and all components within the system and shall verify all aspects of the installation. The test plan shall include integration of the Mobile CCTV system into the MBTA Wide Area Network(s). Notify the Engineer a minimum of 14 days in advance of each test. Engineer or authorized representative reserves the right to attend and approve testing.

3.5 SOFTWARE AND FIRMWARE UPDATES

- A. For the duration of the 5-year warranty period the contractor shall be responsible for the installation or upgrade of 2 major Genetec release updates per year or as directed by the MBTA. These updates shall have no cost to the Authority and will be done at the Contractor's expense and shall not exceed 10 updates total for the Contract duration.
- B. For the duration of the 5-year warranty period the contractor shall be responsible for the firmware updates of all devices installed on the vehicles. The contractor shall be responsible for updating camera, modem and NVR firmware on a bi-annual basis (twice per year) or as directed by the MBTA. These updates shall have no cost to the Authority and will be done at the Contractor's expense and shall not exceed 10 updates total for the Contract duration.
- C. The provisions of Technical Specification Section TS 79 *Software Configuration Control* and TS 80 *Software Escrow* shall apply
- D. The Contractor shall provide a test bench for the 5 year warranty period per the following minimum requirements
 1. Must have active SIM and wireless APN connection for the duration of contract.
 2. Must have 1 piece of equipment per type and be representative of what is currently installed on vehicles (monitor not required).
 3. Shared MBTA / Contractor use to validate upgrades, OS patches and change control location.
 4. Test benches shall be dedicated to MBTA and this contract and will be remotely available to MBTA staff and Engineers 24/7 – 365.
- E. Updates will be bench tested for a minimum of 30 days by the Contractor and bench testing shall include all features and functionality as it exists in the enterprise systems.
- F. All planned updates will be coordinated with the MBTA project management team and coordinated with MBTA Vehicle Engineering to minimize the impact to revenue service.

